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OFFICE OF  
PREVENTION, PESTICIDES AND  
TOXIC SUBSTANCES

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Memorandum

Subject: Rodenticide Incidents Update

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OPP/EFED's ecological assessment of *Potential Risks of Nine Rodenticides to Birds and Nontarget Mammals: a Comparative Approach*, dated July 2004, presented the rodenticide incidents with birds and nontarget mammals known at that time. The incidents are discussed in the assessment, and individual incidents and residue levels are listed in an attachment (Attachment D). Other incidents have occurred since then, and additional reports prior to that time have become available. These incidents are contained in OPP/EFED's Ecological Incidence Information System (EIIS). The current report summarizes the available incident information as of November 2006.

Most of the incident reports for the anticoagulant rodenticides were submitted from the New York State Department of Environmental Conservation (Wildlife Pathology Unit) or the California Department of Fish and Game (Pesticides Investigation Unit). Anticoagulant incidents are based on detection of residue or residues in liver tissue and corroborating evidence from carcass necropsy. Such analyses are expensive, and lack of sufficient funding limits the extent of analyses and incident reporting. As discussed in the ecological risk assessment, most incidents are not reported due to a variety of reasons. For example, most animal carcasses are never found by humans, scavengers quickly remove and consume carcasses, carcasses or ill animals discovered by humans are not reported to proper authorities for a variety of reasons, carcasses discovered and reported are not typically analyzed for rodenticides, and various other reasons.

Incident reports are only one of several lines-of-evidence used to evaluate risk. Other lines include acute toxicity, persistence of compounds in body tissues of primary

consumers (i.e., bait eaters), information from laboratory and pen studies in which poisoned prey are fed to predators or scavengers in various amounts for one or more days, and data from field trials and operational control programs. In many incident reports, the consequence of rodenticide exposure is not known, although in many cases the examining toxicologist determined that a rodenticide likely caused or contributed to the mortality. Anticoagulants typically do not cause death until 4 to 10 days or more after a lethal dose is ingested. However, exposed individuals become progressively weaker and lethargic due to blood loss, and that added stress may contribute to the proximate cause of death. Even if a cause-effect relationship has not been determined for many incidents, the findings of exposure of such a wide variety of nontarget wildlife, both birds and mammals, is a concern. As discussed below, several monitoring programs have found that a major portion of some animal populations are being exposed to second-generation anticoagulant rodenticides.

### **Anticoagulant Rodenticides**

The second-generation anticoagulant rodenticides (SGARs) consist of brodifacoum, bromadiolone, and difethialone. First-generation anticoagulant rodenticides (FGARs) include diphacinone, chlorophacinone, and warfarin. Both SGARs and FGARs are registered for use in and around buildings, transport vehicles, and inside sewers; however, difethialone and bromadiolone are labeled only for indoor use in “non-urban” areas. Diphacinone and chlorophacinone also have field uses (e.g., orchards, rangelands), including hand- or mechanical-broadcast applications for pests such as voles and ground squirrels. These uses are described in more detail in the ecological risk assessment.

### **Avian incidents**

Residues of anticoagulants have been detected in 27 species of wild birds (and 14 spp. of captive birds in zoo incidents), including owls, diurnal raptors and vultures, corvids, and others (Table 1). Other dead or ill birds were reported in some incidents, but the tabulated data include only those birds analyzed for residues. Of the 290 individuals in which anticoagulants were detected, SGARs were detected in 97% and FGARs in 4% (3 birds contained both SGARs and FGARs). Brodifacoum was detected in 87% of the 290 birds and bromadiolone in 13% (brodifacoum and bromadiolone were both detected in several great horned owls).

**Table 1. Detection of Anticoagulant Rodenticides in Birds**

Species	No. detections	SGARs	FGARs
<b>Owls</b>			
Great-horned owl ( <i>Bubo virginianus</i> )	71	71	2
Eastern screech-owl ( <i>Otus asio</i> )	18	18	
Barn owl ( <i>Tyto alba</i> )	8	8	
*Northern spotted owl ( <i>Strix occidentalis</i> )	2	2	
Long-eared owl ( <i>Asio otus</i> )	2	2	
Barred owl ( <i>Strix varia</i> )	2	1	1
Snowy owl ( <i>Nyctea scandiaca</i> )	1		1
Northern saw-whet owl ( <i>Aegolius acadicus</i> )	1	1	
<b>Diurnal raptors</b>			
Red-tailed hawk ( <i>Buteo jamaicensis</i> )	87	85	2
Cooper's hawk ( <i>Accipiter cooperii</i> )	24	24	2
Golden eagle ( <i>Aquila chrysaetos</i> )	13	13	
*Bald eagle ( <i>Haliaeetus leucocephalus</i> )	3	2	1
Red-shouldered hawk ( <i>Buteo lineatus</i> )	3	3	
Sharp-shinned hawk ( <i>Accipiter striatus</i> )	2	2	
Broad-winged hawk ( <i>Buteo platypterus</i> )	1	1	
American kestrel ( <i>Falco sparverius</i> )	2	2	
Peregrine falcon ( <i>Falco peregrinus</i> )	1		1
Unidentified hawk	1	1	
Turkey vulture ( <i>Cathartes aura</i> )	2	1	1
Black vulture ( <i>Coragyps atratus</i> )	1	1	
<b>Others</b>			
Corvids ( <i>Corvus</i> spp.), 3 spp.	20	20	
Turkey ( <i>Meleagris gallopavo</i> ), wild	5		5
Captive birds (3 zoos), 14 spp.	15	15	
Others, 4 spp.	5	5	1
<b>Total birds:</b>	<b>290</b>	<b>278 (97%)</b>	<b>17 (6%)</b>

\* listed (endangered or threatened) species

## Mammalian incidents

Anticoagulant residues have been detected in 218 mammals comprising 17 species, including the endangered San Joaquin kit fox (Table 2). SGARs were detected in 92% of the individuals and FGARs in 18% (both SGARs and FGARs were detected in some individuals). By rodenticide, brodifacoum was detected in 83% of the 218 mammals, bromadiolone in 32%, diphacinone in 13%, chlorophacinone in 6%, difethialone in 5%, and warfarin in 2%. Brodifacoum and bromadiolone were detected together in some individuals, especially bobcats and mountain lions but also several coyotes and kit foxes.

**Table 2. Detection of Anticoagulant Rodenticides in Mammals**

Species	No. detections	SGARs	FGARs
<b>Canids (wild)</b>			
*San Joaquin kit fox ( <i>Vulpes macrotis mutica</i> )	32	27	6
Coyote ( <i>Canis latrans</i> )	25	23	5
Red fox ( <i>Vulpes vulpes</i> )	5	5	
Gray fox ( <i>Urocyon cinereoargenteus</i> )	3	3	
<b>Felids (wild)</b>			
Bobcat ( <i>Lynx rufus</i> )	37	35	7
Mountain lion ( <i>Felis concolor</i> )	30	28	5
<b>Other carnivores</b>			
Raccoon ( <i>Procyon lotor</i> )	10	9	2
Striped skunk ( <i>Mephitis mephitis</i> )		5	
Badger ( <i>Meles meles</i> )	1		1
Long-tailed weasel ( <i>Mustela frenata</i> )	1	1	
<b>Others</b>			
Opossum ( <i>Didelphis virginiana</i> )	5	5	
White-tailed deer ( <i>Odocoileus virginianus</i> )	7	5	2
Gray squirrel ( <i>Sciurus carolinensis</i> )	57	51	9
Others, 4 spp.	5	4	1
<b>Total mammals:</b>	<b>218</b>	<b>201 (92%)</b>	<b>39 (18%)</b>

\* listed (endangered or threatened) species

## Extent of SGAR Exposure in Wildlife Populations

The extent of exposure to SGARS has been reported for several species in the U.S., Canada, and the UK (Table 3). The data from New York also include detections of FGARs, but they comprised only 5% of all detections. In both New York and Ontario, SGARs were detected in more than 80% of all great horned owls analyzed and in more than 50% of the red-tailed hawks. Other owls and raptors in which SGARs are frequently detected include Eastern screech-owls, Cooper's hawks, kestrels, and kites. SGARs also have been detected in 71 to 84% of the kit foxes, bobcats, and mountain lions analyzed in California. Clearly, more information is urgently needed on the potential impacts such exposure may be having on populations of wild canids, wild felids, and raptors.

**Table 3. Widespread Detection of SGARs in Nontarget Birds and Mammals in the U. S. and Elsewhere**

Location/ Species	no. analyzed for liver residue	% positive
<b><i>New York:</i><sup>a</sup></b>		
All (15 species)	265	48*
Great horned owl	53	81
Red-tailed hawk	78	58
Eastern screech-owl	22	45
Cooper's hawk	50	36
<b><i>California:</i><sup>b</sup></b>		
San Joaquin kit fox	32	84
Bobcat	39	79
Mountain lion	35	71
<b><i>Ontario:</i><sup>c</sup></b>		
Great horned owl	24	87
Red-tailed hawk	30	57
<b><i>United Kingdom:</i><sup>d</sup></b>		
Red kite ( <i>Milvus milvus</i> )	20	70
Kestrel ( <i>Falco tinnunculus</i> )	36	67
Polecat ( <i>Mustela putorius</i> )	100	31
Least weasel ( <i>Mustela nivalis</i> )	10	30

Location/ Species	no. analyzed for liver residue	% positive
Stoat ( <i>Mustela erminea</i> )	40	23

\* 6 (5%) positives were first-generation anticoagulants: 3 diphacinone, 2 warfarin, 1 chlorophacinone; 122 (95%) positives were second-generation anticoagulants: 108 (84%) brodifacoum and 28 (22%) bromadiolone (note: brodifacoum and bromadiolone were both detected in 15 birds)

<sup>a</sup> Stone et al. (2003). Bull. Environ. Contam. Toxicol. 70:34-40

<sup>b</sup> California Department of Fish and Game, Pesticides Investigation Unit;  
U. S. National Park Service

<sup>c</sup> National Wildlife Research Centre, Canadian Wildlife Service

<sup>d</sup> Shore et al. (2003). Environ. Poll. 122:183-193  
Burn et al. (2002). Aspects Appl. Biol. 67:203-212  
McDonald et al. (1998). Environ. Pollution 103:17-23

### Non-anticoagulant Rodenticides

Considerably less incident information is available on the non-anticoagulant rodenticides. Some incident information is available for zinc phosphide (ZP; Table 4) but none for bromethalin or cholecalciferol. Most ZP incidents are for waterfowl and wild turkeys. Based on the species and numbers impacted, most ZP incidents likely were due to field applications rather than homeowner use.

**Table 4. Zinc Phosphide Incidents**

Species	No. incidents	No. individuals
<b>Birds</b>		
Turkey ( <i>Meleagris gallopavo</i> ), wild	17	71
Canada goose ( <i>Branta canadensis</i> )	8	157
Snow goose ( <i>Chen caerulescens</i> ) and/or White-fronted goose ( <i>Anser albifrons</i> )	2	~390
Mallard ( <i>Anas platyrhynchos</i> )	1	29
<b>Mammals</b>		
Red fox ( <i>Vulpes vulpes</i> )	1	2
Gray squirrel ( <i>Sciurus carolinensis</i> )	2	20
Eastern cottontail ( <i>Sylvilagus floridanus</i> )	1	1
<b>Total:</b>	32	670